A REVIEW OF INITIAL PROVISIONING POLICIES, PROCEDURES AND PRINCIPLES APPLICABLE TO THE DEPARTMENT OF THE NAVY

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ABSTRACT

Procurements resulting from initial provisioning require considerable expenditure of scarce funds. Provisioning, therefore, must receive high level attention if these already scarce funds are to be most efficiently utilized. Contained herein is a review of the approach to initial provisioning used by the Bureau of Naval Weapons, the Bureau of Ships and the Inventory Control Points. Allied with this overview is a discussion of those principles that must enter into the consideration of any part selection during the provisioning process and their application in today's procedures.

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THE PROBLEM AND DEFINITION OF TERMS USED

The introduction of sophisticated weapons and equipments necessitates a critical review of repair part selection. This review, particularly in relation to the high cost items, must insure that the selections made provide maximum contribution to unit readiness. During the first part of the operational period, support must be provided by repair parts selected mainly on engineering estimates and technical experience rather than empirical usage data. The better the estimates of these requirements the more effective is the support provided within the constraints of the funds and resources available.

I. PROBLEM

It is the purpose of this paper to examine the policies, procedures and principles involved in initial provisioning within the Department of the Navy. This study will encompass a review of the general organization and procedures for the conduct of initial provisioning within two Bureaus of the Navy - the Bureau of Naval Weapons (hereafter referred to as BUWEPS) and the Bureau of Ships (hereafter referred to as BUSHIPS) - and the cognizant Inventory Control Points. From this study it is intended to definitize those elements discovered to be of primary importance in any provisioning situation. Conclusions and recommendations based on the material reviewed will then be presented.

II. DEFINITIONS

<u>PROVISIONING</u>: Provisioning is the process of determining the range and quantity of items (i.e., spares and repair parts, special tools, test equipment, and support equipment) required to support and maintain an item for an initial period of service.

<u>EQUIPMENT</u>: Any equipment, component, system or weapon requiring repair part support.

<u>REPAIR PART</u>: Any part, reparable or non-reparable, used to restore equipment to operating condition.

<u>MILITARY ESSENTIALITY</u>: A relative ranking system which measures the effect of parts failures on the ability of a ship or aircraft to perform its mission or missions.

<u>INVENTORY CONTROL POINT (ICP)</u>: An organizational unit within the supply system of a military service which is assigned the primary responsibility for the management of a group of items, either within a particular service or for the Department of Defense as a whole, including computation of quantitative requirements, the authority to require procurement or initiate disposal, development of world-wide quantitative and monetary inventory data, and the positioning and repositioning of material.

<u>INSURANCE ITEMS</u>: Items for which there may be occasional intermittent demands not sufficiently repetitive to warrant classification as regular stock items; but for which prudence requires that a nominal quantity be stocked for the reason that the essentiality of the items and the lead time required to obtain such items by purchase would create an unacceptable situation if no stock were carried.

CONTRACTOR SUPPORT: An interim arrangement during initial development or production of an equipment whereby a contractor is obligated to furnish to the government, either from production or from stocks maintained by him, items for support of equipment, on an as required basis, pending assumption of support responsibility by the government.

II

BACKGROUND AND REVIEW OF THE LITERATURE

I. BACKGROUND

Provisioning expenditures represent a significant proportion of funds expended for repair parts support during every fiscal year. Prior to the introduction of high performance aircraft, guided missiles and complicated electronic equipment, support was fairly straightforward. It was characterized by parts of minimum complexity and relatively low cost. Many of these were mechanical or electrical in nature as opposed to the complex and high cost components installed in equipments today. It is readily apparent that there cannot be procurement in excess of requirements. At the same time parent equipments worth millions of dollars cannot be out of commission due to lack of parts. It is a fine balance to achieve then in deciding whether or not to initially stock a particular part and then to what depth to stock. Fig. 1 is presented to illustrate the functional interfaces with initial provisioning as seen by the provisioner and to provide an insight into the overall problem.

II. REVIEW OF THE LITERATURE

The literature on this subject, as might be expected, is mainly that originated within the Department of Defense. Readings consisted of instructions promulgated by the Offices and Bureaus within the Defense establishment. In addition, studies conducted both within the Department of the Navy and external organizations such as Rand Corp. and the General Electric Co. (TEMPO) were reviewed. Personal correspondence was initiated as required to obtain supplemental information.

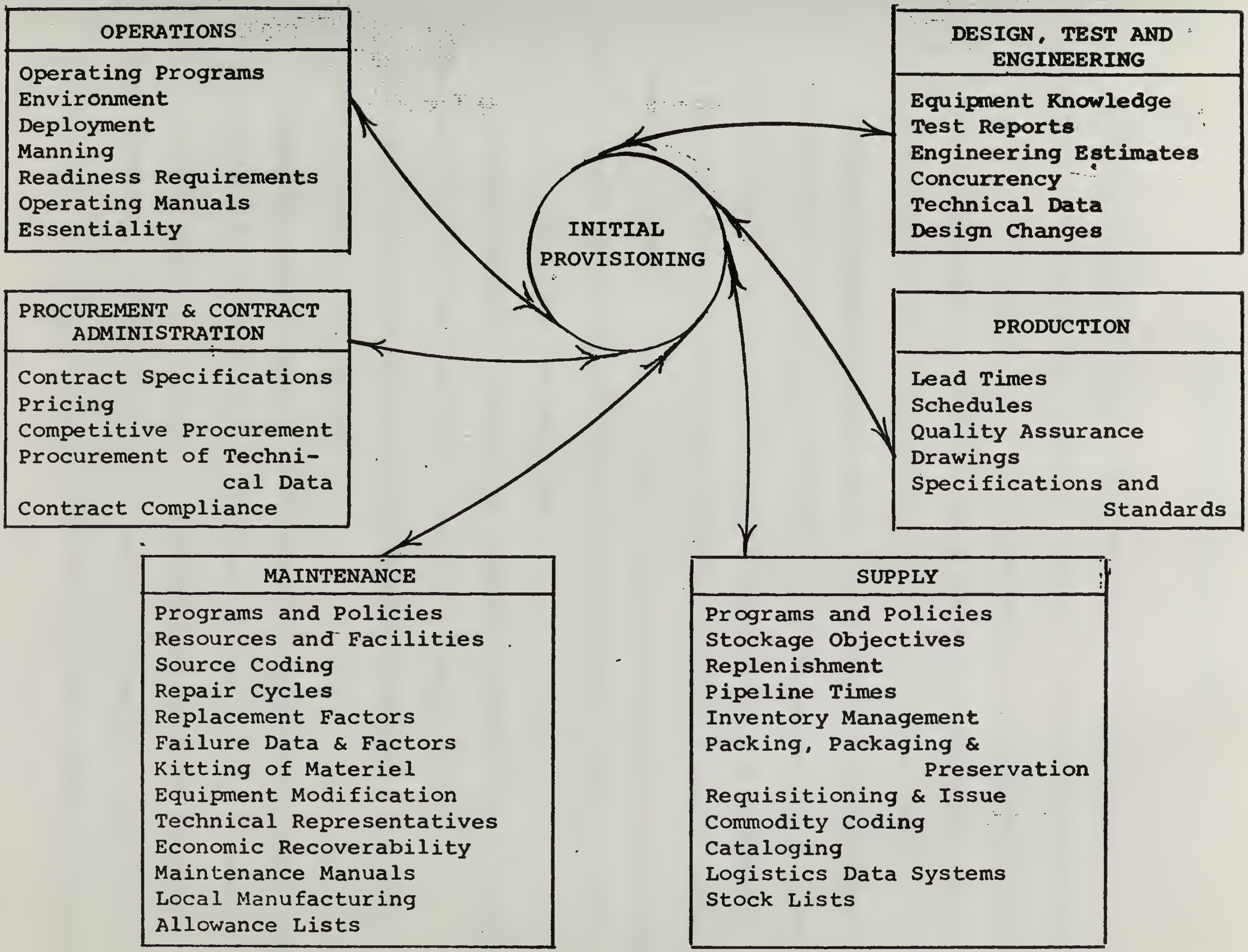

Fig. 1. Functional interfaces with initial provisioning.

III

PROVISIONING RESPONSIBILITIES

Chief of Naval Material. Responsibility for Department-wide policy supervision of all matters related to supply, distribution and disposal of material is assigned to the Assistant Secretary of the Navy (Installations and Logistics). Included among these is provisioning. This responsibility has been delegated to the Chief of Naval Material.[1]

Bureau of Supplies and Accounts. Assist the technical bureaus in developing or revising provisioning procedures which affect Inventory Control Points. Act as co-ordinator as required for the development or revision of joint provisioning procedures affecting several Technical Bureaus or Inventory Control Points. Review performance of the Inventory Control Points for timeliness and effectiveness insofar as provisioning of equipments is concerned.

Technical Bureaus. Develop the necessary provisioning procedures for technical programs under their control. Changes affecting the Inventory Control Points will be developed in consultation with the Bureau of Supplies and Accounts.

Inventory Control Points. Responsible for discharging provisioning responsibilities as assigned by the Bureau of Supplies and Accounts and the Technical Bureaus. Maintain a continuous review of provisioning procedures and, as appropriate, will initiate proposed revisions which will provide for the effective and economical supply support of Navy end items.

[1]Department of the Navy, Secretary of the Navy Instruction 5430.28A; Delegation of Authority Related to Supply, Distribution and Disposal of Navy and Marine Corps Material (Washington: 26 November 1963), p. 1.

IV

BASIC ELEMENTS IN PARTS SELECTION

Current Department of Defense requirements require a program of Integrated Logistic Support[2] for systems and equipments. This is defined as a composite of the elements necessary to insure the effective and economical support of a system or equipment at all levels of maintenance for its programmed life cycle. It is characterized by the harmony and coherence obtained between each of its elements and levels of maintenance.

An important component of this is what we know today as provisioning. Policy requires that logisticians participate actively in all phases of equipment or system development. It also requires that these programs employ techniques for predicting quantitative and qualitative support requirements. Within this framework then sits the provisioner called upon to help in meeting the objectives of this program.

What then are the techniques, guidelines and alternatives available to the provisioning agency to provide support for a new equipment or system? It must consider if contractor support might be the best course of action. If so, then the provisioning decisions are postponed until a later date.

If the decision is to employ Navy support, then important decisions must be made. Among these are what parts to select, whether they will

[2] Department of Defense Directive 4100.35; Development of Integrated Logistic Support for Systems and Equipments (Washington; June 19, 1964).

be selected as unit allowances or only as system items, the depth of support required, and whether to utilize deferred or phased procurements. This Chapter will discuss what are considered to be basic elements of the problem.

Selection depends upon the possibility of a parts failing - is it wearable? Once selected, it is then considered as a repetitive or insurance item depending upon its expected frequency of failure. This selection is now primarily dependent upon the combined experience and judgment of the provisioning team. The decision to stock in the supply system is a fairly safe one insofar as range is concerned but the one to establish it as a ship or unit allowance is a major decision. The cost of placing an item costing several thousands of dollars in scores of ships is obviously substantial and requires studied, scientific decision making. There are several basic factors that must be considered in making either decision.

I SUPPORT PERIOD

The Chief of Naval Operations[3] specifies that support will be provided for a cruise length of ninety days. To this may be added a safety level and reorder time. The problem of the provisioner is to provide the parts necessary to insure operational readiness during this period.

II PARTS POPULATION

This factor is particularly important in determining the depth of support to be provided, particularly that of system back-up. It must include the parts installed in all equipments, not just the ones being provisioned, if they are to be meaningful. This is especially important

[3]Department of the Navy, Office of the Chief of Naval Operations Instruction 4441.12; Supply Support of the Operating Forces (Washington: August 27, 1964).

for insurance items which must not be duplicated when the material on hand will support new equipments being introduced.

III REPLACEMENT FACTOR

In computing depth the expected usage is reflected in the replacement factor. The importance of a realistic one can be appreciated if we are considering the support requirements of high value parts and having populations well into the thousands. An overstatement will result in overprocurement, waste of limited resources and eventual disposal of the parts. On the other hand, an understatement will require, in many cases, a long "get well" period during which operational readiness will be impaired or even negated awaiting arrival of a critical part.

The replacement factor is expressed in such terms as number of failures (1) per hundred population per year, (2) per hour of operation, (3) per flying hour, or (4) per checkout.

There are two problems that are inherent in this area:

First: The first problem requires that accurate and realistic planning information be supplied by the cognizant technical Bureau. If the factor is based on failures/hundred installations/year, for example, then a realistic forecast of yearly operations hours or checkouts must be furnished. The expected use of the equipment affects the life of the part and so determines the rate of replacement. Computations of erroneous allowances and system stocks will be directly proportional to the error in the basic estimation of the replacement factor in this case.

Second: The second problem is how to determine an expected replacement factor. There are two methods that can be considered, either

separately or in combination to arrive at this factor:

A. Provisioning Team. As part of the documentation furnished, the contractor should provide an estimated replacement factor based on one of the criteria previously mentioned i.e., failure/year. In the course of the provisioning this can be reviewed utilizing the judgment of the team plus any failure data accumulated by the contractor to date. In this connection BUWEPS Weapons Requirements No. 30[4] provides an excellent tool for obtaining useful data from the contractor based on data recorded during the early stages of the project development and testing. This document provides through a single set of integrated documents much information not previously available.

It must be recognized that there are certain pitfalls that are inherent in this approach. These are:

1. The contractor's experience may likely be based on laboratory or non-operational experience as opposed to actual fleet usage. What may rarely fail under laboratory conditions using highly trained and experienced personnel may not stand up under shipboard conditions and maintenance by fleet personnel.
2. Contractor personnel may be overly optimistic and tend to minimize expected failures to bolster their predicted operational capabilities of the equipment.
3. Parts that are susceptible to competitive procurement may not contain the "know how" built into them by the prime contractor and can experience a higher failure rate.
4. A learning curve situation may present itself in many cases.

[4]Department of the Navy, Bureau of Naval Weapons, Weapons Requirements No. 30 Integrated Maintenance Management for Aeronautical Weapons, Weapons Systems, and Related Equipment (Washington: May 1, 1963).

Until maintenance personnel become experienced with the equipment both wrong diagnosis of failures and inadvertant destruction of parts may be expected. This, of course, will inflate early replacement requirements and cause parts shortages.

B. Mean Family Replacement Factor. A technique has been devised for use by the Ships Parts Control Center in initial provisioning situations called the Mean Family Replacement Factor.[5] Under this concept, repair parts are grouped by noun name into families and by service codes into sub-families. An average Replacement Factor is then determined for each sub-family. These rates, since they apply to similar parts in similar equipments, can be reasonably expected to approximate the subsequent true replacement factor. It is most certainly a far better approach than the strictly intuitive judgment of a provisioner. If used in conjunction with the Provisioning Team concept, it can assist in providing a best estimate of what will actually occur when the equipment is placed in service use.

C. Conclusion. The setting of a replacement factor cannot be a seat of the pants decision but must utilize the best scientific approach possible. A combination of the various means appears to offer the best solution and one that will best hold up in the face of later usage.

An indication of the uncertainty that is always present in initially determining a replacement factor is shown by Fig. 2 below representing spare parts used in support of the Tartar/Terrier Surface to Air Missile.[6]

[5]Department of the Navy, ALRAND Report No. 42 - Mean Family Replacement Factors (Mechanicsburg: Ships Parts Control Center, March 1964).

[6]Personal letter from D. Bender, USN Ordnance Supply Office.

Component	Initial R/F	Dec. 1964 R/F
Guidance Assy.	.03	.122
Receiver Assy.	.02	.119
Instrument Set	.03	.075
Control Surface	.02	.006

Fig. 2. Tartar/Terrier Comparative Replacement Factors

The problem that this represents is readily apparent in terms of depth, both in over and understocking. Overstocking can be resolved early in the program by making excesses available to the contractor as Government Furnished Material if they are still compatible to parts in production. If not or the last production run has occurred, then the inevitable task of eventual disposal looms in the future. Understocking impedes fleet support and in the case of long lead items presents a continuous problem of many months duration.

IV. APPLICATION

These three elements can be used in the determination of both unit allowances and initial system stocks. This approach is quite straight forward and simply an exercise in mathematics.

The basic application is by the formula of Replacement Factor X Parts Population X Support or Stocking Period. The product should then give the theoretical quantity that can be expected to be used during the period.

This method assumes a uniform usage during the year and does not consider the possibility of variables such as unequal distribution of failures or probability of no usage during the period. There are no constraints such as essentiality or cost built into it. It is basically

an elementary device lacking a sophisticated approach to the problem of what and how much to buy. The main disadvantage in using this alone without considering other variables is the danger of sparing many parts as a unit allowance that could be stocked ashore. These could still provide essentially the same protection and contribution to the units mission as they do as part of an allowance list.

V

ADDITIONAL ELEMENTS IN PARTS SELECTION

I. MILITARY ESSENTIALITY

One important, and possibly the most important consideration, is the military essentiality of the part. As previously defined, military essentiality is a relative ranking of parts in relation to their effect on the units mission when failure occurs.

The current military essentiality program was promulgated by the Chief of Naval Operations on 23 November 1962.[7] This instruction divided the areas of coding into FBM, Fleet, Aircraft and New Construction. Through the use of questionnaires, fleet and unit commanders were to determine the essentiality of individual components/equipments. Based on these findings, the Bureau of Supplies and Accounts would show the codes in the index and stock number sequence listing of allowance lists published by its activities. While providing guidelines, it left execution of the program primarily to the Fleet Commanders. These guidelines were fairly broad and the implementation is not an easy job.

As defined in the basic instruction, the objective is to establish a basis whereby ships and squadrons can formally evaluate the relative military importance of on board equipments. The military importance assigned to an equipment will be determined by relating the function of the equipment to the accomplishment of assigned missions. At the Fleet level, the same degree of military essentiality assigned to the equip-

[7]Department of the Navy, Office of the Chief of Naval Operations Instruction 4423.1A; Fleet Military Essentiality Coding (MEC) Program (Washington: November 23, 1962).

ments/components will be applicable to the repair parts supporting these. Military essentiality will be expressed as a numerical code which reflects the relative importance of the equipments/components contribution to the unit's mission.

In the face of space or fund constraints it provides a medium for selection of those parts contributing most to the readiness posture of the unit. It can provide a guide for the ship's supply officer in obtaining maximum effectiveness from the expenditures of his limited operating funds by replacing the high military essentiality items first.

An early study[8] measured essentiality of equipments to a submarine's mission and the effect of a part failure without a replacement on board. The results are shown in Fig. 3 with worth category shown in descending order.

Worth Category	Mechanical and Electrical	Electronics	Ordnance
1A	1857	0	203
1B	434	0	48
1C	229	0	17
2A	1498	1123	288
2B	227	1666	61
2C	253	80	49
3A	3292	2829	89
3B	415	5921	14
3C	523	405	71
4A	767	1107	293
4B	104	1714	176
4C	253	230	101
	9852	15,075	1410

Explanation of Worth Category:

1 - 3 - Worth of Component, High to Low

A - C - Worth of Part, High to Low

[8]Marvin Denicoff, Joseph Fennell and Henry Solomon, "Summary of a Method for Determining the Military Worth of Spare Parts," Naval Research Logistics Quarterly, September, 1960, pp. 221-234.

Fig. 3: Distribution of all parts pertaining to each type of component of a conventional submarine.

With the advent of the Fleet Ballistic Missile program increased studies[9] were done in relation to military essentiality. From these evolved a system of rating a part numerically from low to high, the latter representing the highest essentiality. These were derived by use of a questionnaire wherein equipments and components were rated as to mission effect, redundancy and alternative while repair parts were graded in relation to component dependence and installability. The combination of the answers then determined the rating assigned.

Findings based on a study of the USS George Washington (SSBN-598) are shown in Fig. 4. Participating personnel were guided by the following assumptions in completing the military essentiality questionnaires:

1. The submarine is on a normal patrol cycle.
2. During the patrol cycle no supply or maintenance support is available from any external source.
3. A given failure could occur on the first day of patrol and the submarine would have to suffer the loss of the performed function for the entire patrol period.
4. The Polaris weapons system is composed of six independent sub-systems of equal military essentiality: launcher, fire control, navigation, missile, missile test and readiness, and ship.

The last sub-system, ship, consists of the nuclear submarine itself.

[9] Marvin Denicoff and others, The Polaris Military Essentiality System, George Washington University, Logistics Research Project (Washington: July 24, 1964).

RELATIVE ESSENTIALITY	MEC CODES	COMPONENT-EQUIPMENTS	PART APPLICATIONS
Highest	116	6%	4%
High	115 . . . 94	14%	15%
Intermediate	93 92 91	26%	25%
Low	90 89 88	54%	44%
Lowest (p=3)	87 . . . 59	Does Not Apply	12%
	Total Range	2,987 Component Equipments	55,918 Part Applications

Fig. 4. MEC code distribution for USS GEORGE WASHINGTON (SSBN-598)

This data is easily obtained. Contractor, Bureau and Fleet personnel are able to quickly and consistently fill out the equipment and component questionnaires.

It is significant to note that only 19% of the parts and 20% of the component-equipments were evaluated as being of a high essentiality. The study also shows that a good spread of relative essentiality is obtained over the allowance list range.

The findings show a very distinct ability to cull out those repair parts of low essentiality as an item of shipboard allowance and stock only as a tender or system item. The dollar and space savings resulting from such a decision should be readily apparent and could indeed be substantial.

II. MILITARY ESSENTIALITY THROUGH READINESS INDICES

A new approach to essentiality is Military Essentiality Through Readiness Indices (METRI), a technique for measuring readiness of complex systems.[10]

The technique originated from a need to accurately measure the military essentiality of spare parts for shipboard use. In this technique, military essentiality is defined and measured as the contribution by any constituent (sub-system, component or part) of a system to the capability of the total system to perform in terms of readiness. Through the use of a mathematical model the readiness contribution is measured in terms of an indice ranging from 0 to 1.0.

For provisioning use the contribution (ΔR) of a particular repair part to the overall readiness can be calculated. Based then on a predetermined criteria, a determination can be made whether to specify this as a ships allowance item. The value of this approach is clearly seen when dollar constraints in particular are present. Proper utilization of this concept will direct the available funds towards those parts, both for allowance and system stock, that contribute most towards system readiness.

[10]Clark, Cooper, Field and Wohl, Inc. METRI Interim Working Document (Stamford, Connecticut: July 18, 1963).

One current report[11] indicates marked savings and increased effectiveness for this technique based on the allowance list for the AN/SPS 40 radar aboard the USS Ellyson (DD 864). The inference is that similar results will occur with other equipments. It is difficult to evaluate these claims based on the material available at the date of preparation of this paper. It may be that the provisioning action on this radar was not of high calibre. Or it may be that the allowance calculated under METRI will not provide adequate support over time in light of actual usage. In any event, the basic concept appears sound and does provide another tool in helping to select those parts that will provide the most protection per dollar.

III. SHORTAGE COSTS OR PENALTIES

The General Electric Co. (TEMPO)[12] has proposed the computation of a shortage penalty for each unit (hour, day, etc.) of down time suffered by the equipment due to lack of a spare part. The summary states, "The shortage penalty is the sole reason for the existence of spare parts." The object of this particular study is a guided missile squadron. Cost per hour of down time is used as a measure and is calculated based on an amortized acquisition cost plus normal operating cost. The purpose of the repair part then is to avoid this penalty cost by keeping equipment in an "up" status insofar as spare parts are concerned. Using this concept, changes in the probability of being operational at a given point in time can be equated to the cost of spare parts to achieve this status.

[11] Clark, Cooper, Field and Wohl, Inc., The Metri Allowance List Technique (Stamford, Connecticut: August 18, 1964).

[12] H. M. Markowitz, Shortage Penalties in Missile Spare Parts Logistics (Santa Barbara: General Electric Co. (TEMPO), December, 1958).

It is proposed that this shortage cost for any equipment is easily obtained from a cost effectiveness curve which can be plotted for each equipment. An example of such a curve is shown in Fig. 5. For each point on the curve GG' there is an implied cost, or shortage penalty. The report further states that this shortage penalty associated with any particular point on the curve is merely the slope of the curve at that point. Fig. 5 shows two points with their corresponding slopes. As can be seen the slope at R', the point of greater cost and effectiveness, is also greater.

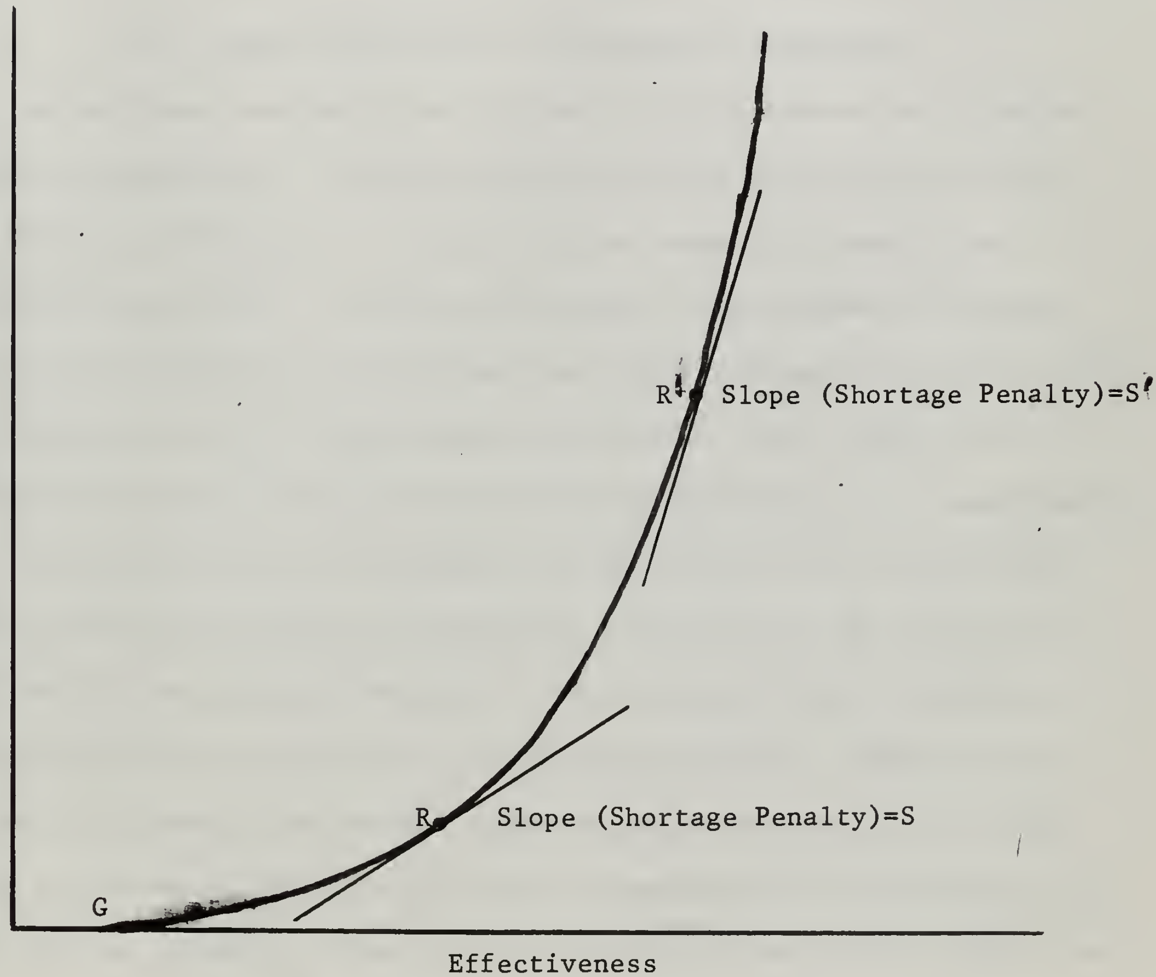

Fig. 5. Relationship of shortage penalty to cost effectiveness curve.

It is suggested that this concept has more widespread application in a single mission unit rather than a multi-mission one. It does give a point of departure for determining what the worth of reduced down time is of an equipment. That is to say, if it is desired to reduce expected down time by X hours per year then the value of this can be calculated based on this precept. The total hour reduction multiplied by the shortage penalty provides the dollar worth of this reduction. This worth must then be equated to the cost of additional spares necessary to achieve this.

IV. PHASED PROVISIONING AND DEFERRED PROCUREMENT

An important consideration, and one receiving increasing attention within the Department of Defense today is that of phased provisioning and deferred procurement when there will be quantity production or follow-on contracts.[13] Phased provisioning is a management refinement to the provisioning process whereby quantity procurement of selected items is deferred until the later stages of production. This enhances the ability of the provisioning activity to more reliably predict requirements.

In lieu of quantity procurement of repair parts on the first order under initial provisioning, arrangements are made with the contractor to increase his production inventory of these selected items in limited quantities as prescribed by the provisioning activity. The increased production inventory serves as a buffer stock to demands on the system. These stocks may be in various states of completion as prescribed by the provisioning activity. These are not included in the initial orders for

[13] Department of Defense Instruction 4140.19; Phased Provisioning of Selected Items for Initial Support of Weapons Systems, Support Systems and Equipment (Washington: July 31, 1963).

parts placed for initial stocks. On a time-phased schedule the provisioning activity conducts a provisioning redetermination on the items held in the buffer stocks. It uses the latest in-service experience to: (1) place additional quantities on order for delivery into system stocks, (2) change or affirm the quantities being held as buffer stock, and (3) release some buffer stocks being held in light of lower than anticipated demands. This redetermination process is repeated periodically until final disposition is made of the buffer stock. This final determination must be made in advance of the final production run to insure utilization of all unneeded stocks.

The principal objective of initial provisioning is to assure the timely availability of items in the appropriate supply and maintenance echelons. These buffer stocks maintained in an up-dated configuration at the contractor's plant constitute back-up support for the supply system. This then provides for minimum quantities to be held within the Navy since these buffer stocks will be available to satisfy demands.

Its use can be further enhanced through education of the provisioners and overcoming of contractor resistance. There are many advantages to be gained from invoking such a procedure. Some of these are:

1. More experience is gained on usage rates and thus more intelligent decisions can be made in relation to final selection of spare parts for allowances and system stock.
2. Components held by the contractor are updated automatically to the new configuration as design changes are made. This precludes recall of the units from the Navy Stock Points and helps to prevent a mixed stock situation.

3. Shortage costs and loss by inventory at the Stock Points are avoided.

4. Stocks are readily available at the contractor's plant and can be furnished expeditiously through the use of premium transportation.

It therefore is incumbent that the Technical Bureaus and provisioning agencies consider most carefully the utilization of this procedure in initially provisioning a new equipment.

V. STATISTICAL APPROACH

In determining range and depth of repair parts, another concept is one utilizing the chance of failure and level of protection required. It may not be either rational or economical to attempt to insure 100% availability during any particular support period. In fact, in view of fund availability it may be impossible for all practical purposes. This concept can be applied to both single, high cost items and either single or families of low cost parts.

In any part there is an inherent degree of reliability affording a certain percentage of protection during any period. The addition of more parts will, of course, incrementally increase this level of protection towards 100%. The characteristic of any failure distribution curve is such, however, that as the level of protection or chance against stock out is increased a disproportionate amount of stock is required to accomplish this. It then becomes a question of how much it is worth to reach a particular level or probability.

As part of the logistic policy for any new equipment, the relative importance of it towards the primary mission of the ship or aircraft could be determined by higher authority prior to the provisioning. It

could then be determined, based on the importance of the equipment, what level of protection is required consistent with the readiness desired. In other words, the desired protection against stock out of essential parts. Based on this, and using statistical methods in conjunction with a computer facility, the provisioner can determine the range and depth of parts necessary to achieve this objective during the support period.

Figures 6 and 7[14] based on demands per quarter over time, illustrate this principle. With no spares on board, there is still a 64% level of protection during any quarter. The problem that exists is that of uncertainty as to which quarters the demand will be zero. An allowance or stocking level of one will increase the level to 77% while two will provide 84% protection against stock out.

Possible Demand	Frequency of Occurrence	Probability of Demand	Quantity Stocked	Probability of Stock Out
0	64	.64	0	.36
1	13	.13	1	.23
2	9	.09	2	.14
3	2	.02	3	.12
4	4	.04	4	.08
5	1	.01	5	.07
6	2	.02	6	.05
7	1	.01	7	.04
8	3	.03	8	.01

Fig. 6. Demand and Summation of Probability and Risk for Hypothetical Repair Part. Based on Demand per Quarter.

[14]Usage data figures and graph taken from ALRAND Report No. 20 - Demand (Mechanicsburg: Ships Parts Control Center, September, 1960).

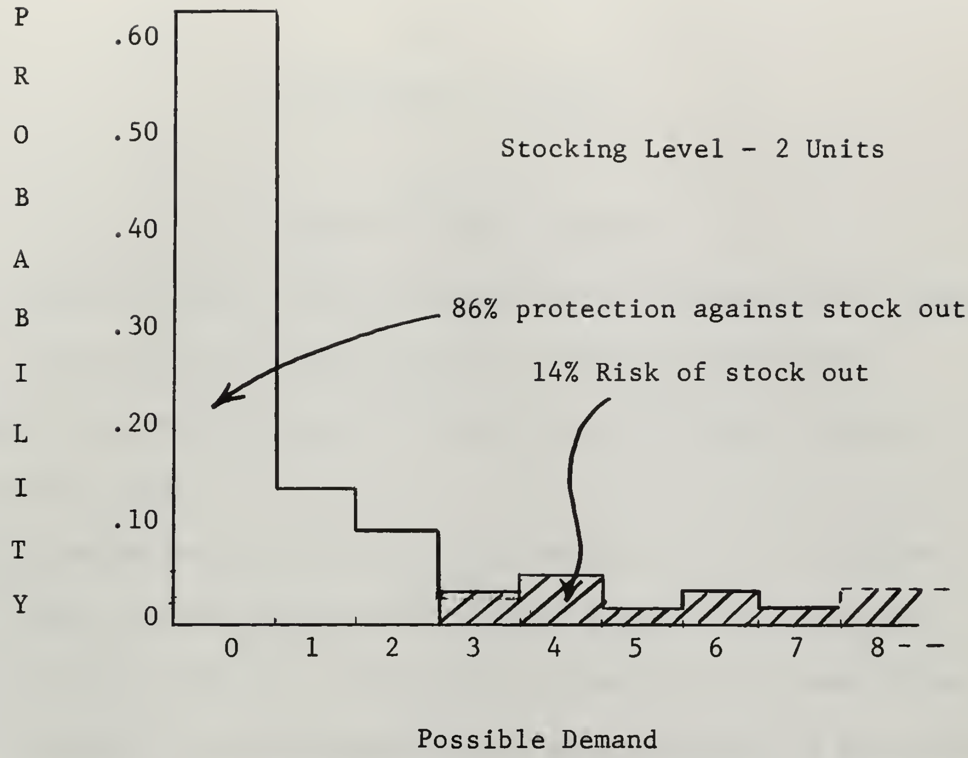

Fig. 7. Graphic Representation of Risk.

It then becomes apparent that it requires a sharp increase in cost to achieve a small increase in protection after the first units are added. At this point the decision maker must exercise his ability and decide on the level of protection to be provided.

VI

THE TECHNICAL BUREAUS

I. BUREAU OF NAVAL WEAPONS

The Bureau of Naval Weapons responsibility encompasses all Naval weapons, Navy and Marine Corps aircraft, airborne target drones, photographic and meteorological equipment and astronautic vehicles and equipment thereof.

Provisioning is carried out through the facilities of the USN Aviation Supply Office, the USN Electronics Supply Office and the USN Ordnance Supply Office. The latter is scheduled for disestablishment on 30 June 1965 and equipments being supported will be distributed between the Ships Parts Control Center and the Electronics Supply Office.

Basic policy concerning provisioning is contained in the latest revision of BUWEPS Instruction 4423.2.[15] This lays out responsibilities of the various factions concerned with provisioning i.e., Bureau codes, BUWEPS Fleet Readiness Representatives, ICPs, etc. It also deliniates the various types of conferences necessary to insure a successful provisioning of an end item. Direction for support of any particular equipment normally flows as the result of a Support Planning Policy Conference attended by Government and contractor personnel responsible for spares, training, support equipment, publications and other logistic commodities as considered necessary. The conference is convened by BUWEPS to establish, prescribe and promulgate the maintenance and support

[15]Department of the Navy, Bureau of Naval Weapons Instruction 4423.2; Procedures Governing Support Planning Policy and Provisioning Conferences (Washington: February 7, 1961).

policy for the equipment concerned. Some of the more important determinations made are:

1. Level of Maintenance
2. Commercial Overhaul Requirements
3. Training Requirements
4. Support Equipment Requirements
5. Target Dates for Completion of Support Action

From this conference is developed the Logistic Support Plan for the equipment. This plan provides further guidelines to assist the provisioners in the selection of the repair parts.

There are three follow-on type conferences utilized in providing support through provisioning. These are:

1. Provisioning Conference. This is the conference convened to accomplish selection of the repair parts. It is chaired by the cognizant ICP and is attended by Bureau, Fleet Readiness Representatives, Contractor and Fleet representatives. In addition to establishing allowance requirements it determines: (a) maintenance and overhaul requirements, (b) source, accountability/recoverability and kit codes, (c) commercial overhaul requirements, (d) raw material requirements, and (e) maintenance level function classification. The BUWEPS Technical Representative is charged with the responsibility for the "range and quantity of Allowance List/initial outfitting items". While the actual quantities decided upon normally represent the composite thinking of the group it is he that has the ultimate responsibility.
2. Interim Support Conference. This is a stop gap operation initiated by the ICP to provide a support kit to users when it

is determined that the normal provisioning process cannot provide repair parts support by the Navy Support date. It is intended to provide a minimum range and depth of parts on an interim basis.

3. Technical Review Conference. This is convened as required by the Bureau to review the requirements generated by the Provisioning Conference. It would appear that its real value is manifested when requirements exceed funds available and reductions must be made.

BUWEPS uses various "Weapons Requirements" prescribing the procedures, terms and conditions governing the selection, procurement and delivery of repair parts and documentation. They call out responsibilities for the activities involved insofar as submission of documentation, conferences, repair parts orders, parts deliveries, etc. are concerned. These cover end items of equipment, support equipment, technical documentation and test and evaluation equipment. In addition there are ones for Contractor Support (WR-2) and Integrated Maintenance for Aeronautical Weapons, Weapons Systems and Related Equipment (WR-30). The latter is particularly significant in that it provides for the possibility of complete initial support planning with comprehensive documentation. Through the submission of Maintenance Engineering Analysis Records data is provided for use in determining repair parts requirements, allowance documents and provides much additional information not previously available. It is a positive step toward a truly Integrated Logistics Support Planning.

II. BUREAU OF SHIPS

The Bureau of Ships responsibilities encompass those shipboard mechanical, electrical and electronic equipments other than ordnance equipments under Bureau of Naval Weapons cognizance. The Ships Parts Control Center and Electronics Supply Office provide provisioning service for these equipments. For provisioning purposes these are divided into mechanical/electrical and electronic with different Military Specifications applicable to each.

Mechanical/Electrical Equipments. Provisioning of these equipments is conducted under the provisions of MilSpec MIL-P15137A, B, or C. The bulk is now being processed under Revision C although some hulls exist that are being provisioned under A or B. The major difference between the three is that under Revision C the ICP determines the range and depth of the on-board repair parts which will be produced. There are two methods of carrying out the provisioning under Revision C, Method A and Method B. Under Method A the shipbuilder is permitted to buy a range and depth of repair parts based upon definitive listings prior to approval by the ICP. He does this under the contingency that he must adjust his procurement to compensate for any changes the ICP may make in the range and depth selection. Under the Method B approach the shipbuilder is not permitted to buy these until receipt of processed provisioning from the ICP. The intent of this arrangement was to utilize Method A for the private builder and Method B for Naval shipyards in order that the latter could use system stocks where available. In actual practice the private builder is also utilizing the Method B approach to insure against overprocurement due to changes in allowances.[16]

[16]Personal letter from LCDR C. P. Foreman (SC) USN, Ships Parts Control Center.

Prior to Revision C the shipbuilder would use either the definitive lists cited in the specification, the manufacturers recommendations or his own recommendations for procuring range and depth of on-board repair parts. However, the ship's allowance list was finally determined by the ICP and resulted in either overages or shortages in parts for the ship. The C Spec. was developed to minimize as much as possible this problem and it now appears that it has reduced it to a great extent.

The MILSPEC also provides for provisioning conferences and definitizes a time table for submission of documentation and placing of orders for repair parts.

Electronic Equipments. Guidance for provisioning of these equipments is contained in Military Specification MIL-E-17362D (Ships). Guidance is provided for the determination and procurement of electronic repair parts by both BUSHIPS and the Electronics Supply Office. There is contained within the Specification detailed delivery schedules for both allowance and system stock repair parts. It also provides for the convening of a provisioning conference if required by the Navy or contractor.

VII

INVENTORY CONTROL POINTS

I. USN ORDNANCE SUPPLY OFFICE

The USN Ordnance Supply Office is responsible for provisioning of BUWEPS designated shipboard equipments including surface-to-air and air-to-air missiles and underwater ordnance. It will be disestablished as of 30 June 1965 and its functions transferred to the Electronics Supply Office and Ships Parts Control Center. However, it is considered relevant to discuss its procedures since they reflect BUWEPS policies and direction which can be reasonably expected to be carried over to the succeeding ICPs.

Selection of allowance range and depth are the responsibility of the BUWEPS technical representative (normally the Fleet Readiness Representative) at the provisioning conference. Provisioning is conducted under the provisions of WR-1 and WR-5. For each equipment an Equipment Support Plan is prepared giving all the information available to the provisioner prior to the actual conference.[17] This is updated as changes occur or new information is received. Among the more important items contained therein are:

1. BUWEPS maintenance policy.
2. Activities to receive allowances.
3. Total number and relative design stability of the equipments being provisioned.
4. Fitting out yards.

[17]Department of the Navy, USN Ordnance Supply Office Instruction 4423.1C; Policies, Procedures, Responsibilities for Provisioning (Mechanicsburg: January 31, 1962).

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

5. Stock points to be utilized.

6. Guidelines for deferred and phased provisioning.

7. Budgetary guidelines.

While allowance items are theoretically a function of the BUWEPS technical representative, provision is made for computation of allowances on the part of the OSO provisioner when directed to establish or recommend allowances. The basic formula is Replacement Rate X Support Time X Parts Population. If the product is less than one then the so-called insurance formula is invoked to evaluate the item as an insurance item. This formula is R x E x I x L where R is the Replacement Rate, I is the essentiality to the equipment, I is the investment loss while inoperative and L is lead time in months to reorder. If the resultant is greater than the cost of the part, then it is positioned on board as an insurance item. This procedure does differentiate between active and insurance items and thus at least a close review of the part is performed by the technician. Initial quantity of system back-up stocks is procured on the Replacement Rate x Time x Population basis with time dependent upon whether it is a reparable or non-reparable item. Military essentiality is not a major consideration, probably due to the general state of the program. Thus, there is no attempt to keep items with low essentiality off shipboard allowances. The replacement rate used is determined at the provisioning conference. It can be based on the contractor's recommendation, similarity to an established item, the judgment of the provisioning team or a combination thereof.

II. USN ELECTRONICS SUPPLY OFFICE

The USN Electronics Supply Office is responsible for the provisioning

of all BUSHIPS electronic equipments. Provisioning is accomplished in accordance with BUSHIPS MilSpec MIL-E-17362D. Guidance is provided by BUSHIPS in the form of an equipment support letter setting forth the type and degree of Navy support required.

Selection of range of parts is based on technician experience, contractor recommendations, failure factors, available failure studies and Fleet and Bureau representative recommendations. Items selected are divided into four categories:

1. Repetitive use Item. Wear is apparent, visible or expected and has a failure rate between .21 and 1.00.
2. Random Use Item. Characteristics and structure preclude the determination of the actual failures expected to occur. The failure rate is between .03 and .20.
3. Insurance Item. Experiences occasional demands but not sufficiently repetitive to be considered a regular stock item. The failure rate is between .01 and .02.
4. Deep Insurance Item. A high cost, high essentiality item with a failure rate of .00 to .009. These are purchased in a quantity of one for carrying point stocks only.

Whether the part is picked up as a unit allowance is determined on the basis of Allowance Tables which relate total applications to allowed quantities. These are based on ninety days support. The current approach is to provide for a 90% probability of being in stock.[18] These tables generally provide a proportionally greater allowance of repair parts for a small number of applications than for a larger number. For computer

[18]Personal letter from A. Hakala, USN Electronics Supply Office.

purposes, the tables have been reduced to a series of hyperbolic curves of varying progression. These progressive variations are considered sufficient to cover the complete range of failures.

Ships have been divided into eight groups for allowance purposes. A ship is assigned to a group depending on stowage area available or whether it carries a load list.

Each new item of supply in a provisioned equipment is assigned an appropriate allowance table for each ship group and POA base.[19] To assist in table assignment, a listing of part names by generic name, essential characteristics, and recommended allowance tabling is maintained. This listing has been correlated to some extent with failure rates. The system has inherent limitations in that parts used in more than one equipment tend to retain the table assignment based upon the first provisioned equipment. In addition, there is only one assignment for each part, no matter how many equipments use the part. These limitations are not considered to be serious since table assignments can be revised to reflect important equipments during periodic review.

Initial system stocks of other than deep insurance items are computed using the formula of failure factor X total parts population X one year. There is a provision for an override if conditions warrant.

Currently Military Essentiality coding considers the item as either a high or low essentiality and is so coded. It is intended to expand this to four levels as soon as essentiality codes are implemented to the equipment. This will provide a finer degree of differentiation in

[19]Department of the Navy, USN Electronics Supply Office Instruction P4423.6: Electronics Supply Office Provisioning Manual (Great Lakes, Illinois: March 18, 1958).

deciding on parts selection.[20]

The Electronics Supply Office, because of the nature of the parts managed, is geared to a table type operation susceptible to rapid machine calculation. Provision is made for exception managing of high cost items. This, in conjunction with the aforementioned technique, appears to provide a suitable base for conducting a successful provisioning.

III. SHIPS PARTS CONTROL CENTER

The Ships Parts Control Center acts as the provisioning agent for Bureau of Ships Hull, Mechanical and Electrical equipments. As previously stated, the bulk of the provisioning for BUSHIPS is conducted under the provisions of BUSHIPS MIL-P-15137C. Program information is received in various forms: (1) Monthly Vessel Progress Report, (2) NOBs/N600 Contracts, and (3) Inspector of Naval Material DM Letters. These basically tell the ICP those ships requiring spare parts and what equipment is scheduled for installation. Difficulty is encountered when the contract for equipments does not specify all the hulls to receive them. This then requires continual follow-up with BUSHIPS and the probability of not knowing if provisioning is being accomplished on time for a specific hull. Selection of range of items for the system is governed by the following criteria:[21]

1. All items of a nature subject to wear and/or repetitive replacement during normal shipboard maintenance and shipyard overhauls except as listed in sub-paragraph 3 below.

[20]Personal letter from A. Hakala.

[21]Department of the Navy, <u>Ships Parts Control Center Instruction 4423.4; Provisioning Policies and Criteria; establishment of</u> (Mechanicsburg: May 24, 1957).

2. All items of an insurance nature for critical equipments.

3. The following type items will not be recommended for stock:

   a. Those having acceptable equivalents or substitutes in stock.

   b. Items capable of shipboard fabrication.

   c. Items commonly available from commercial shelf stock.

   d. Non-insurance type items with an anticipated total annual requirement of 3 or less.

   e. Items with an annual dollar demand of less than $10.00 regardless of quantity.

   f. Items making up low cost sub-assemblies or small components.

Shipboard allowances are established by the provisioner using technical judgment and allowances for similar or like parts. The depth is based on one years support or 4,000 hours of operation. These are then approved by BUSHIPS and then become what is known as the master Allowance Parts List (APL) for that equipment.

Military Essentiality is divided into High, Intermediate, and Low criticality. It is used in determining if an insurance-type item should be stocked. While not so stated in available instructions, it appears reasonable that when establishing an allowance the provisioner will temper his judgment with the particular class of criticality into which the part falls.

IV. AVIATION SUPPLY OFFICE

The Aviation Supply Office is responsible for provisioning of Bureau of Naval Weapons aeronautical systems and equipments. Broad

guidance is provided in the current revision of BUWEPS Instruction 4423.2. Program information for each provisioning is provided in the form of a Logistics Policy Statement. If the system or weapon is a large one, a Logistics Guidance Team is set up to monitor and provide assistance.

Selection of range of parts to be carried is done as a team effort at the provisioning conference with BUWEPS as the final authority on the selection.

Generally, items are established as an allowance item if they have a specifically predicted or actual usage rate of one or more in a ninety day period. In the case of low or no demand items considered to be military essential items, these will also be included as a unit allowance. A military essential item is described as one that will cause an aircraft to be out of commission for its primary mission and has an expected usage of one in two years.

Quantity determinations are based on a chart (Fig. 8) which considers the unit cost of the part in relation to the maintenance factor, quantity per aircraft and the maintenance cycle.[22] As the product of the latter three increases, the quantity of spares also increases. Under this system, price is a major consideration in the quantity to be procured. With all other things equal, the parts with the lower unit costs will be stocked in greater depth than those with higher costs.

[22]Department of the Navy, USN Aviation Supply Office, Allowance Lists Policy and Procedures. Enclosure 1, pp. 10-13.

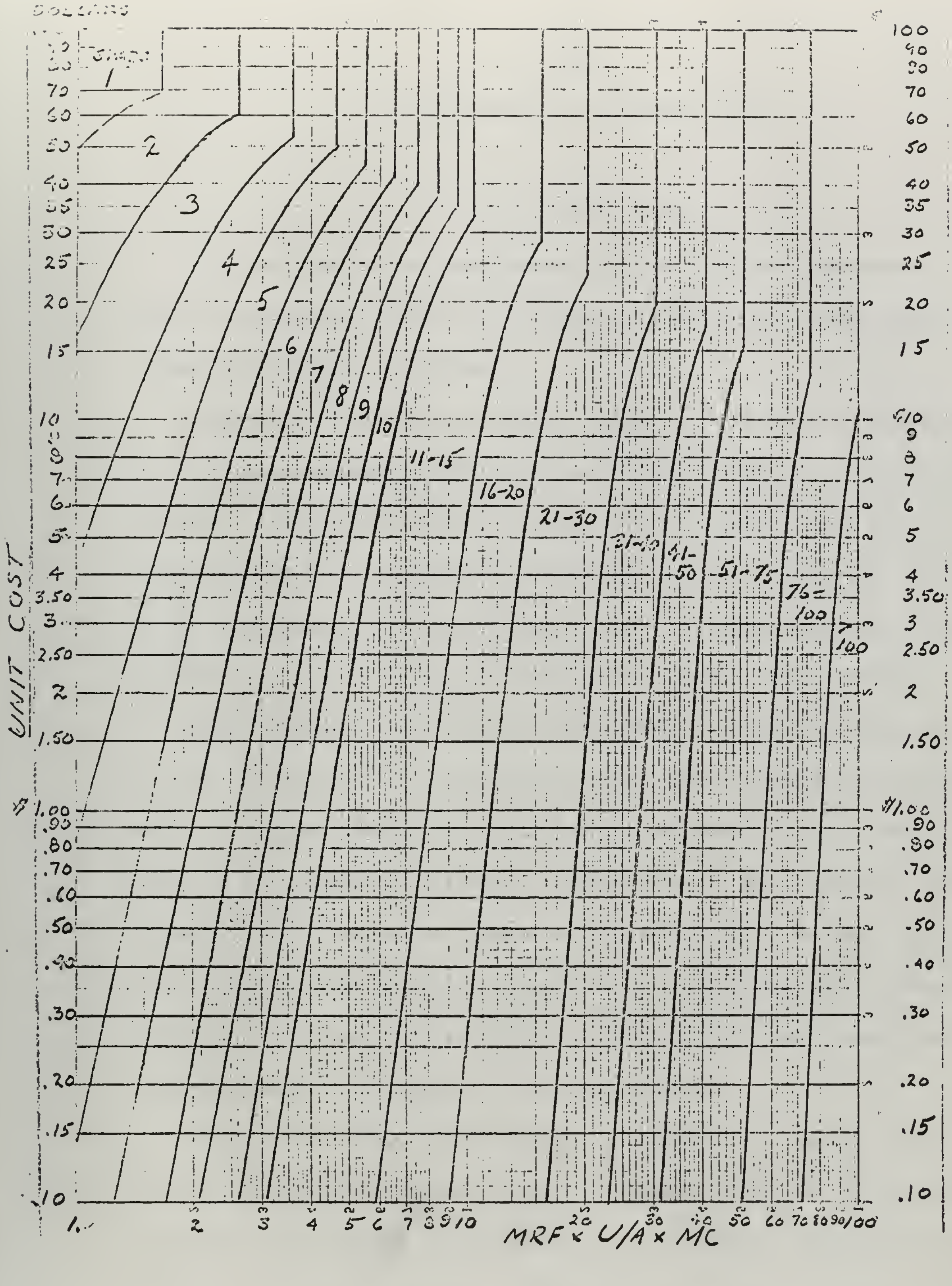

Fig. 8. Computational chart for aeronautical repair parts.

VIII

CONCLUSIONS AND RECOMMENDATIONS

I. CONCLUSIONS

The many and varied equipments used within the Department of the Navy compound the problem of providing adequate and timely support through initial provisioning.

Success is dependent upon many factors. There must be early and clear program guidance from the Chief of Naval Operations and Technical Bureaus. This guidance must provide the provisioner with all the information necessary to identify and consider all the variables present in any provisioning situation. Programs must be instituted early enough to provide for an orderly and intelligent provisioning process.

Once provided with program information the provisioning team must be able to identify and rank those repair parts that will contribute most to the operational readiness of the equipment. The provisioner must use a scientific approach to the problem. No longer must intuitive judgment be the basis for the selection of a part. He must consider cost, military essentiality, space and all the other factors and constraints related to part selection. This will in many cases require a complete change in approach by the provisioner.

The use of phased provisioning and contractor support in the early life of the equipment offer a means to attain adequate early support and concurrently build up the data base from which ultimate selection of spare parts will be made. Judicious use of this technique will assist in eliminating the mistake of over and under procurement from which it is difficult to recover.

The peculiarities of equipments make standardization of procedures difficult. However, there are principles such as military essentiality that have universal applicability that can be consistently applied by all provisioners in deciding whether to stock a spare part.

Successful provisioning then depends on a knowledgeable approach by everyone concerned - the buyer, producer and user. Each must contribute his expertise if the final product is to be a profitable one.

II. RECOMMENDATIONS

The following recommendations are considered worthy of study and/or initiation. They are based on research conducted within the limitations of available time and material and as such are not deemed to be all inclusive or infallible. It is recognized that work is proceeding on some of these recommendations. For others the difficulties are great and implementation may prove to be unfeasible from a practical viewpoint. However, they are in every case deserving of consideration. Adoption of any or all will improve the provisioning process currently being followed.

Centralized direction in provisioning is vested in the Chief of Naval Material. Review of the current instructions indicates that the individual Bureaus independently determine their own policies and procedures. Central guidance and policies should be promulgated within the Navy Department to insure that all requirements set forth by the Offices of the Secretary of Defense and Navy and other regulatory offices are universally adhered to. Standardized provisioning in connection with the BUSANDA Uniform Automated Data Processing System for Inventory Control Points will provide a measure of uniformity in the mechanics for

the ICPs. However, central direction is still required to develop uniform guidance to the provisioners that make range/depth selection of the spare parts.

The Inventory Control Points should be responsible for the selection of range and depth of spare parts. This can be accomplished under decision rules established by higher authority prior to provisioning. These rules can be set up on a permanent basis and modified if necessary to satisfy individual equipment requirements. With the large number of design and other engineering changes that new equipments now undergo, this will also provide a rapid determination and procurement of new parts required as part of these changes. This will also insure that the ICP will be aware of any parts added as an allowance after the provisioning conference and will take expeditious action to procure them.

The Military Essentiality of an item should be used more extensively in selection determination of individual unit allowances. It is suggested that many low essentiality parts with application in several units can be removed from the allowance lists. These could be stocked at selected distribution points and moved via premium transportation if necessary to satisfy the sporadic demands that may occur. There are undoubtedly many of these, particularly the so-called insurance items, that could be removed without affecting the operational readiness of the particular activity.

Concurrently, the use of METRI and similar techniques should be expanded to provide a basis for intelligent utilization of scarce funds. These techniques, however, must be brought into the realm of understanding of the provisioners that are expected to use them. While the actual

manipulations can be done by computer, it will still require correct human inputs, if it is to work properly.

In determining depth of spares, the probability of stock out at the unit level during the support period must be a major consideration. The reliability of the parent equipment and failure rate of the part must be considered in the determination of the level of protection desired. This desired level of protection must be decided upon by higher authority. It will then be the responsibility of the provisioner to satisfy this during the provisioning process.

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